Control of Dipole-Dipole Interactions and Radiative Decay in Dielectric Structures

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Novel methods have been proposed by us for the enhancement or suppression of atomic or molecular resonant dipole-dipole interactions (RDDI) and radiative decay (fluorescence) in dielectric structures:

A. Mode density control is effected by the structure geometry and boundary conditions in dielectric resonators, photonic crystals and waveguides and dielectric microspheres [1]. This control allows the inhibition of radiative decay, while keeping intact the dipolar coupling to selected field modes. The unusual and highly promising regime of strong dipolar coupling to a single mode can lead, depending on the coupling strength, to drastic enhancement or suppression of RDDI at interatomic separations much shorter than the resonant wavelength [2]. Whereas RDDI suppression leads to the inhibition of energy transfer processes, its enhancement may lead to the formation of giant dimers and long-range order [3].

B. Dynamical control can be effected by off-resonant laser pulses at a high repetition rate [4]. If the rate exceeds the spectral width of donor and acceptor bands of molecules coupled by RDDI, this control can be chosen to cause either the acceleration or the inhibition of both radiative decay and energy transfer in the medium.

The implications of these control methods for quantum computing will be briefly discussed.

References

1. G..Kurizki et al ., New Journal of Physics 2, 28.1 (2000); G.Kurizki et al., in the Encyclopedia of Optical Engineering (Dekker, 2001).
2. G.Kurizki et al., Phys.Rev. A53, R35 (1996).
3. B.Deb and G.Kurizki , Phys.Rev.Lett. 83, 714(1999); quant-ph/0012079.
4. A.G. Kofman and G.Kurizki , Nature 405 , 546 (2000); Phys.Rev.A 54, R3750 (1996); quant-ph/0107076.